DOI:
10.1016/j.healthplace.2018.07.002

Document Version
Peer reviewed version

School Racial Composition and Lifetime Non-Medical Use of Prescription Painkillers: Evidence from The National Longitudinal Study of Adolescent to Adult Health

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ABSTRACT

Objective: To investigate the possible effects of middle and high school racial composition on later reporting of lifetime non-medical use of prescription painkillers (NMUPP) in young adulthood, and to explore whether there is evidence of variability by individual race/ethnicity in such effects.

Methods: Using data from Wave 1 (1994/5) of the National Longitudinal Study of Adolescent to Adult Health (Add Health), we categorized the sample's 52 middle schools and 80 high schools as majority (>50%) non-Hispanic white, majority non-Hispanic black, or neither. We used two-level hierarchical modelling to explore associations between individual- and school-level race at Wave 1 and lifetime prescription painkiller misuse reported at Wave 4. We included a cross-level interaction between individual race and school racial composition to assess variability in school-level associations by race.

Results: Overall crude prevalence of lifetime NMUPP in majority white schools (17.9%) was over three times that of prevalence in majority black schools (4.8%), and also higher than prevalence in schools neither predominantly black nor predominantly white (12.4%). Lifetime misuse among blacks in majority white schools was more prevalent (5.2%) than among blacks in black schools (2.8%), as was misuse among whites in white schools (19.3%) compared to their white peers in black schools (15.7%). Two-level random intercept Poisson regression results suggest that attendance in a majority black secondary school lowered a participant's risk of lifetime NMUPP (compared to attending majority white school: Model 3, RR=0.66, p=0.03). Compared to blacks in black schools, blacks in white schools had twice the risk of prescription painkiller misuse (p=0.004) over a decade later, and whites in white schools had 5.5 times the risk (p=0.01). The risk ratio comparing whites in black schools to whites in white schools was not significant (RR: 1.30; p=0.37).

Conclusions: We found evidence of an effect of school racial composition on the risk of misusing prescription painkillers over a decade later, over and above individual race, with higher risk of misuse reported among participants who had attended white schools. Black participants who had attended predominantly white schools were, on average, twice as likely to report lifetime misuse of prescription painkillers compared to blacks who had attended black schools.

Keywords: prescription painkiller substance race multilevel add health

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Introduction

Remarkably consistent variability by race and ethnicity in substance use has been observed in the U.S., with highest rates reported among non-Hispanic whites across substances such as cigarettes, alcohol, marijuana, and other illicit drugs [1]. Similar disparities have emerged in the rise of misuse of prescription medications, including the nonmedical use of prescription painkillers (NMUPP). In one large, nationally representative cross-sectional study, non-Hispanic white participants aged 12 to 17 were more likely to report non-medical use of opioids (10.5%) than were Hispanics (9.4%) or non-Hispanic blacks (8.9%) [2]. Studies involving college students also show higher prevalence of misuse of prescription drugs among whites than among racial and ethnic minority groups [3]. Similar patterns—with an often more pronounced relative protection for blacks—have continued to surface for adolescents and young adults in recent years [4, 5].

The mechanisms underlying this consistent variability by race are not fully known, but a protective effect for blacks and Hispanics—for prescription drug misuse in particular—might arise from the well-documented disparities in prescribing by doctors, who in multiple studies have been shown to treat pain differentially by race of patients, with far higher prescribing rates for non-Hispanic whites compared to minorities [6-8]. Compounding this disparity is the striking difference in the stocking of opioids in pharmacies, with facilities in minority neighborhoods often understocked, while pharmacies in white neighborhoods carry more adequate quantities of the demanded painkillers [9, 10]. There is also some evidence that religiosity might have a protective influence against substance use [11, 12] by acting as a buffer against stress [13]. Such protection could be more prevalent among blacks and Hispanics, who are more likely to report being religious [14, 15]. A so-called “immigrant effect” might be an alternative explanation for lower rates of drug use among Hispanics, who are more likely to be immigrants, a status that has repeatedly been linked to lower rates of cigarette, alcohol, and other illicit substance use [16-21].

While the literature on the topic has grown along with the opioid epidemic, researchers have noted the dearth of longitudinal studies examining factors tied to the non-medical use of prescription drugs, due to a

heavy reliance on cross-sectional data [22, 23]. As the lifecourse perspective emphasizes, exposures at formative times (e.g., adolescence) can exert significant and enduring influence on health outcomes throughout the lifespan [24-26], making longitudinal studies crucial to our understanding of disease patterns. Explorations of the roots of prescription drug misuse would also benefit from the inclusion of school-level characteristics, as previous work has revealed the critical role the school environment can have on shaping the risk-taking behaviors of adolescents and young adults [27-36]. Given the differences reported by individual race in prescription drug misuse, a worthy focal point for investigation of higher-level measures would be racial composition at the school level, and its potential influence on prevalence of prescription painkiller misuse, above and beyond the role of individual race and ethnicity. Research has shown the powerful influence of the school environment in introducing adolescents to behavioral modeling, social norms of peers, and increased access to substances [27-30]. Evidence suggests substance use varies significantly across schools for smoking [31-33], drinking [34], and marijuana use [35]. Because early initiation of substance use in adolescence predicts misuse later in life [29, 36], it is particularly important to explore any lasting associations between school environment and prescription misuse evident in adulthood.

The aim of this study is to determine whether an association exists between non-medical use of prescription painkillers and school-level racial composition, over and above any relationship between NMUPP and individuals' race, and whether such a relationship varies by individual race. This preliminary exploration is motivated by at least four hypothesized mechanisms explaining possible disparities by race at the school level. First, it is known that schools affect behavior of adolescent students by establishing and reinforcing social and behavioral norms [29, 37]. Social influence theory highlights teens' desire to conform to group norms in behavior and attitude [38]. A majority-white school setting where prevalence of substance use is likely to already be elevated might therefore lead to further reinforcement and perpetuation.

Alternatively, health disparities by school racial composition might be explained by the effects that segregated settings could have on psychosocial pathways. Minority students in majority white schools experience more racial discrimination and harassment [39]; such experiences can lead to social disengagement

[40]. Higher rates of substance use have been seen among teens reporting feeling of disconnection from their schools [41]. Substance use has also been seen to be a coping mechanism for the stress that discrimination causes [42-44]. Minority students in high-percentage white schools, therefore, might be more at risk for substance use, including NMUPP.

Third, school-level variation in substance use could stem from differences in school regulations. Schools with tighter regulations and policies regarding punitive repercussions of illicit substance use, it might be argued, could see lower rates of drug use; the same might be true in schools with programs promoting social norms discouraging such behavior. However, evidence suggests that such policies have more of an impact on overt behavior as opposed to covert behavior [45]; their effectiveness, therefore, might be far greater for an activity like smoking than for a behavior like swallowing a pill, which is easier to conceal.

A fourth possible mechanism involves the practical matter of access. As noted above, non-Hispanic whites are most likely to be prescribed painkillers [6]. Pharmacies serving minority populations have been seen to be severely understocked with opioid analgesics compared to pharmacies in white neighborhoods [9, 10]. The most common source of diverted prescription medications for misuse among teens and young adults is friends and family [46, 47]. These facets of access could work in concert to ensure that NMUPP would be most prevalent in schools with high percentages of white students, where prescriptions would be more abundant.

To our knowledge, there has yet to be a study assessing the influence that school-level racial composition in adolescence might have on misuse of prescription painkillers reported in early adulthood. This gap is unsurprising, as most work on health effects of segregated settings has focused on segregation at the neighborhood level [48]. Recent exceptions include work by Bifulco et al. [49], who found evidence of increased marijuana use among students in high-percentage-black school cohorts but no significant effects for post-secondary outcomes. Walsemann and colleagues [50] reported that depressive symptoms among blacks increased as the percentage of white students in schools they had attended rose. Results of work by Goosby and Walsemann [51] exposed a harmful association for blacks between previous attendance in a predominantly white school and self-rated health in young adulthood.

Exploiting the rich longitudinal data from Add Health, we follow students who attended middle and high schools of different racial compositions to see whether there is evidence of an enduring association between school-level racial composition in adolescence and lifetime non-medical use of prescription painkillers reported in young adulthood. Using hierarchical regressions that include cross-level interactions, we run the rough equivalent of a fictitious experiment to see if any variability in effect estimates for school context vary by race/ethnicity among our sample population. We hypothesize that higher prevalence of lifetime NMUPP in young adulthood will be seen among study participants who attended majority white schools compared to those who went to majority black or neither majority schools in adolescence, and that this association will be significant, even after adjustment for individual-level race. We also predict that blacks who attended white schools will be at increased risk of NMUPP compared to blacks who were in black schools in their teen years, while whites who attended predominantly black schools will be less likely to report misuse in adulthood.

Methods

Sample

Data come from the National Longitudinal Study of Adolescent to Adult Health (Add Health), an ongoing, nationally representative sample of students from 132 schools in the U.S. (80 high schools and 52 feeder schools) [52]. Systematic sampling methods and implicit stratification in its sample design ensure that the Add Health sample is representative of U.S. schools with respect to region of country, urbanicity, school size, school type, and ethnicity.

Add Health began in 1994, with four instruments used in its first wave (Wave I, conducted from September of 1994 through December of 1995); two surveys used in Wave II (conducted from April through August of 1996); multiple sources in Wave III (August 2001 through April of 2002); and one in-home survey conducted in Wave IV (January of 2008 through February of 2009). Wave V data collection is underway as of March 2017. According to the University of North Carolina, where it is administered, “Add Health is the largest, most comprehensive longitudinal survey of adolescents ever undertaken.” Instruments include in-school questionnaires, as well as in-home interviews of not only the students themselves, but also their parents and

siblings. Other data are collected from school administrators, fellow students, and romantic partners of the students surveyed. Add Health also includes contextual variables garnered from pre-existing databases.

The initial in-school questionnaire was administered to 90,118 students in grades 7 through 12 in the 1994-1995 academic year. Of these 90,118 students, 20,745 were then given more involved at-home surveys, and were re-interviewed in the following Waves. Approximately 15,000 participants were interviewed at both Wave 1 and Wave 3, as well as at both Wave 1 and Wave 4. The majority of participants in the survey were aged 18 to 26 years old at Wave 3, and 24 to 32 years old at Wave 4. Add Health collects information on respondents' demographic, social, and behavioral characteristics, along with (more recently) certain biomedical samples.

The sample for this analysis was restricted to those respondents completing in-home surveys at both Waves 1 and 4 (n=15,701). Participants missing parental income data from the parent questionnaire (Wave 1) were excluded (2,371 missing and 1,328 whose parents refused to report income), as were those missing information on race (n=19). Seventeen additional respondents were dropped for missing outcome, and three more were excluded for missing age data, leaving an analytic sample of 11,602.

Measures

Nonmedical Use of Prescription Painkillers

The primary outcome for this study was self-reported lifetime non-medical misuse of prescription painkillers (NMUPP). In the in-home survey at Wave 4 in 2008, participants were asked a series of questions about substance use, including non-medical use of prescription drugs. The first of these questions assessed lifetime non-medical use of any kind of prescribed drug: "Have you ever taken any prescription drugs that were not prescribed for you, taken prescription drugs in larger amounts than prescribed, more often than prescribed, for longer periods than prescribed, or taken prescription drugs that you took only for the feeling or experience they caused?" Respondents answering "yes" were then instructed to report on specific types of prescription drugs: sedatives, tranquilizers, stimulants, and painkillers. Our binary outcome measure is based on responses to the question capturing painkiller misuse: "Which of the following types of prescription drugs have you taken that

were not prescribed for you, taken in larger amounts than prescribed, more often than prescribed, for longer periods than prescribed, or that you took only for the feeling or experience they caused? (check all that apply)… pain killers or opioids, such as Vicodin, OxyContin, Percocet, Demerol, Percodan, or Tylenol with codeine." For those responding affirmatively, the outcome variable NMUPP was coded "1"; for all others, the variable was coded "0."

Race and Ethnicity at the Individual and School Levels

Our independent variables of interest (individual race/ethnicity and school-level racial composition) come from respondents' self-reported primary race at the Wave 1 1994/1995 in-home survey. We categorized respondents as non-Hispanic white, non-Hispanic black, Hispanic, and all other non-Hispanic ("other"). From this individual-level measure of race/ethnicity we then constructed our variable for each school's racial composition by calculating their respective populations' percentages of non-Hispanic whites and of non-Hispanic blacks. Schools with >50% non-Hispanic white students were categorized as "majority white," with >50% non-Hispanic black "majority black," and the remaining schools "neither." Wave 1 grand sampling probability weights were used in aggregating data to ensure that numbers were representative of schools' actual populations. The in-home survey was chosen rather than the larger in-school data due to evidence of substantial race/ethnicity reporting bias [50]. Using the in-home data as a source of racial composition has resulted in measures highly correlated with available Common Core administrative information on a portion of the Add Health high schools (correlation of 0.99) [50].

Individual-Level Covariates

Participant demographic characteristics were taken from data collected at Wave 1. Both sex and age have been shown to significantly predict non-medical use of prescription drugs [23, 53-55]. Other potential individual-level confounders of interest include parental educational attainment and family household income. Parental education was measured as the higher of maternal or paternal education level reported in the Wave 1 parental

questionnaire, and categorized as less than high school; high school; some college; college; or more than college.

Socioeconomic status in adolescence was also captured using family pre-tax income at Wave 1. The measure was derived from parental reports of total pre-tax family income (in $1000-increments, top-coded at $999,000) given by parents of respondents at Wave I in the separate parent questionnaire administered in 1994. The measure was equivalized for household size by dividing the reported total family income figure by the square root of the number of household members. The sample was then divided into quartiles based on participants' values for this variable.

School-Level Covariates

We adjust for the following possibly confounding factors at the school level: region of country (West, Midwest, South, Northeast); school size (small, medium, or larger); and school type (private vs public). To explore the possible contextual effect of school-level SES, for supplemental analyses we created a dichotomous variable for low- versus high-income schools, using as a cut-off the median of the medians of family income across all schools.

Statistical Analysis

Initial analyses were conducted using SAS version 9.4 (SAS Institute; Cary, NC) and multilevel analyses were done in STATA 14.2. Overall crude prevalence of lifetime painkiller misuse was first calculated for the full sample (n=11,602), and then for each of the three categories of school (majority NHW, majority NHB, and neither). Both unweighted and weighted prevalence estimates were calculated. The sample was stratified by race/ethnicity to determine the crude proportion of NMUPP for each subset of race category within the three types of schools. Additional stratification was done by school-level SES (family income) at Wave 1 to assess prevalence based on that level-2 measure.

In addition to these assessments of crude proportion of reported lifetime non-medical prescription painkiller misuse, we ran two-level random intercept Poisson regressions to assess the risk of lifetime NMUPP by race and by school characteristics. In order to test for variability by race/ethnicity in contextual school-based effects, we included interaction terms between level-one individual race and level-two school-wide racial composition.

Results

School Racial Composition

Table 1 displays the breakdown of school-level racial composition for our Add Health sample schools at Wave 1. Of the 132 schools, the majority (n=88) had student populations that were over 50% non-Hispanic white at Wave 1. Only 14 schools were majority non-Hispanic black. The remainder (n=30) had neither >50% black populations nor >50% white populations.

Crude Prevalence of NMUPP in Young Adulthood by School Type Attended

As seen in Table 1, at Wave 4, 15.8% of the full sample reported lifetime misuse of prescription painkillers. Prevalence of misuse of these prescription drugs was higher among non-Hispanic whites than among non-Hispanic blacks: 19.4% vs 4.2%, respectively, and was 9.5% for Hispanic participants. The proportion of young adults reporting painkiller misuse was highest among those who had attended predominantly white schools in adolescence: 17.9%. This fraction was nearly 4 times larger than the proportion of those reporting misuse who had attended predominantly black schools in their teen years (4.8%) and was also higher than the percentage reporting NMUPP who had attended neither majority black nor majority white schools (12.4%). Results of a Pearson's chi-square test showed these differences to be statistically significant ($p<0.0001$).

Further breakdown *within* each of the three different categories of schools attended reveals that non-Hispanic white individuals consistently had the highest proportions of reported NMUPP, regardless of school racial composition: 19.3% (whites from white schools), 15.7% (whites from black schools), and 21.5% (whites from neither type of school). Non-Hispanic black participants had much lower proportions, though misuse was

more prevalent among those who had gone to majority white schools (5.2%) or to schools categorized as "neither" (5.2%), compared to those who had attended majority black schools (2.8%). Lifetime NMUPP estimates for Hispanics fell between that of whites and blacks, with highest percentages among those who had attended predominantly white schools (12.8%) and lower numbers for those who had gone to majority black (10.3%) or neither majority (7.9%) schools. For those participants classified as "other" (not non-Hispanic black, non-Hispanic white, or Hispanic), highest prevalence of NMUPP was seen in those who had attended neither majority schools (12.9%), compared with 10.7% among those who had attended predominantly white schools, and zero among those who had gone to majority black schools in adolescence, although the number of participants in that subset was very small (n=20).

Multilevel Results

Multilevel Poisson regression models were run to estimate the relative risk ratios for lifetime non-medical use of prescription painkillers in young adulthood. Model 1 (results not presented) included only individual race: compared to whites, blacks had 0.28 the risk of misuse at Wave 4, Hispanics had 0.53 the risk, and those categorized as "other" had 0.60 the risk (p-value <0.001 for all estimates). Inclusion of individual-level covariates—age, sex, household income quartile in adolescence (Wave 1), and parental education—in Model 2 (not presented) had negligible impact on the estimates for race. Estimates for parental education revealed an increased risk of NMUPP with higher parental educational attainment (compared to the reference group of less than high school), although the increased risk of the highest group (>college) was lower than that of those with parents only graduating from high school (RRs of 1.44 and 1.52, respectively). The effect of family income was not statistically significant. In Model 3 the school-level racial composition variable was added, and results suggested an additional protection for those who had attended a predominantly black school in adolescence (Table 2, RR: 0.66, p=0.03) compared to those who had gone to a predominantly white school. For our final models (Models 4 and 5), cross-level interactions between individual race and school racial composition were added. To allow for interpretation of relative NMUPP risk for each classification of participant (by individual

race and by type of school attended) compared to their peers, we ran two separate models in which only the reference group was changed: Model 4 in Table 2 displays results from models in which whites who went to majority white schools were assigned to be the reference group; Model 5 presents results when the same model was run, but with blacks who attended black schools as the reference. We present these two models because they enable us to directly compare NMUPP use across school categories, separately for white, black, and Hispanic students. Compared to blacks who had gone to majority black schools (the reference group in Model 5), white participants who had attended majority white schools had 5.5 times the risk of later lifetime NMUPP reported in young adulthood (calculated by multiplying Model 5's RR for "White" (7.20), by RR for "Majority White School" (2.14), by RR for interaction term, "White in White Majority School" (0.36); p=0.01); compared to Hispanics from neither majority schools, whites from white schools had 2.1 times the risk of NMUPP (from Model 4: inverse of product of RRs for "Hispanic" (0.76), "Neither Majority School" (1.04), and interaction term "Hispanic in Neither Majority School" (0.59); p=0.01). Compared to blacks from black schools, blacks from predominantly white schools had twice the risk of prescription painkiller misuse (Model 5, RR for "Majority White School": 2.14; p=0.004) over a decade later. The risk ratio comparing whites in black schools to whites in white schools was not significant (Model 4, RR for "Majority Black School": 1.30; p=0.37).

Supplemental Analysis: School-Level SES

Supplemental Table 2 shows further breakdown of schools by school-level income across racial composition categories. Fifty-seven majority white schools at Wave 1 had median family incomes higher than the overall median income for the sample, while only one majority black school fell into that category. Low-income schools classified as neither majority black nor majority white far outnumbered high-income "neither" schools (22 vs. 8).

Supplemental Table 3 presents crude prevalence of NMUPP reported by participants at Wave 4, stratified by composition of secondary schools attended. Because only one school was classified as both high-

income and majority black, sample numbers for that school were too low to report for non-Hispanic whites, Hispanics, and others. Prevalence in majority white schools and neither majority schools was higher overall in those schools that were high-income: 18.4% for non-Hispanic white high-income vs 14.6% non-Hispanic white low-income; 12.1% for neither majority high-income vs 8.7% neither majority low-income. Proportions of participants reporting NMUPP who had attended predominantly non-Hispanic black schools were similar for high-income and low-income black schools: 4.6% vs 4.5%. However, among blacks who attended majority black schools, crude prevalence is twice as high in high-income schools (5.8%) as in low-income schools (2.9%). Patterns are similar, though differences not as large, for blacks and for whites who attended majority white schools, though differences for Hispanics and for others are quite small: 14.7% and 13.9% in high-income white schools vs 14.3% and 16.7% in low-income white schools, respectively. The only evidence for any crude prevalence higher among those who went to low-income vs low-income schools can be seen in reports by non-Hispanic whites who attended neither majority schools, with 19.1% from high-income schools and 21.9% from low-income schools reporting NMUPP.

Discussion

In our multilevel analysis following participants over fourteen years, we found evidence of a lasting influence of racial composition at the secondary school level on later health in young adulthood. Risk of nonmedical use of prescription painkillers was highest among those participants who had attended a majority white school in adolescence, supporting our first hypothesis. At first sight, our results might seem to suggest that in some cases, being in the minority group at a school is associated with higher risk of NMUPP. However, differences among white students from predominantly white schools versus white students from predominantly black schools were not statistically significant (RR: 1.30; p=0.37), possibly reflecting the small number in our sample of white students who had attended black schools (n=63). Future studies, however, should examine this hypothesis using larger samples. Our prediction that the association between school-level race and lifetime NMUPP would vary by individual race, therefore, could not be supported. Finally, we found evidence that blacks who attended white

schools had significantly higher rates of misuse than did blacks who had attended black schools. This association persisted nearly 15 years after participants were in their middle and high school environments.

The multilevel nature of our analyses allows us to begin to tease out the compositional from the contextual effects at play. While individual-level race remains a significant predictor of NMUPP in all adjusted models, the school-level effect estimates indicate that factors in the school environment influence risk of nonmedical use of prescription painkillers over and above factors at the individual level. Our results echo the findings of Goosby and Walsemann [51], which revealed an association—among young black adults—between earlier attendance in higher percent white schools and poorer self-rated health later in young adulthood. We find similar evidence of apparent harm for blacks in a school environment where they are the minority, with those students reporting higher rates of lifetime nonmedical use of prescription painkillers.

The exact underlying mechanisms driving the differences in reported NMUPP seen in our results are impossible to pin down without further analysis. The prescription drug misuse disparities by school racial composition might stem from the effect of (harmful) social influence of white students' prescription misuse on the behavior of black students in majority-white schools [38] and from the consequences (as predicted by a contagion or epidemic model, [55]) of daily interaction and contact with students misusing opioids. Adolescents are particularly susceptible to the influence of social and behavioral norms within their schools [37]; these behaviors—ingrained at a formative time—are often carried over into young adulthood.

Psychosocial pathways could also explain these disparities. While attending a predominantly white school might offer more resources than a black school would have allowed [51], for a black student it would also dramatically increase the likelihood of experiencing health-damaging racial discrimination [39]. As previous research has shown, blacks might therefore be more susceptible to engaging in substance use as a coping mechanism [42-44]. This risk seems particularly high for students who find themselves in an environment where NMUPP prevalence is higher and such behavior accepted as normative.

It remains possible that school-level variation in substance use could reflect variability in school-wide regulations. However, this explanation seems less likely than others, given that evidence is weak for the

effectiveness of such policies [45], and the unlikelihood of the existence of school-based regulations specifically targeting prescription medication sharing and misuse.

Perhaps the most plausible mechanism underlying the disparities in NMUPP seen in our study involves actual access of students to prescription drugs. A wealth of evidence points to far higher prescribing rates by doctors for non-Hispanic white patients compared to other racial and ethnic groups [6, 7]. In addition, at the neighborhood-level, pharmacies in predominantly white areas have strikingly higher stocks of opioid analgesics than those in minority neighborhoods [9, 10]. Since adolescents misusing prescription drugs usually gain access to them via friends and family [46, 47], exposure to more peers with more prescriptions would put black students in white schools, for example, more at risk than they would be in predominantly black schools.

Our supplemental analysis looking at high- vs low-income schools points to a fertile area for future study. While our study was constrained by small sample sizes limiting subgroup analysis, there is evidence of a school-level SES effect as well as a racial composition effect. It would be valuable to explore whether NMUPP patterns vary by school-level SES, as limited research has suggested is the case for other types of substance use and abuse at a level higher than that of the individual. For example, analysis of results from the Department of Housing and Urban Development's Moving To Opportunity randomized social experiment have indicated a harmful effect—among males—of moving out of Section 8 housing into assignment in a different, higher-income neighborhood. Compared to controls, males in the treatment group reported higher rates of using marijuana, cigarettes, and alcohol in the last 30 days [56]. Rates among the treatment group were three times higher for alcohol use, and even higher for the other two substances. Opposite effects were seen for female participants, though not all differences were significant.

Strengths and Limitations

To our knowledge, this is the first study to look at school context with respect to prescription drug misuse. It is also the first to look at enduring associations between school racial composition and later reporting of lifetime non-medical use of prescription painkillers in young adulthood. The innovative nature of our study begins to fill a critical gap in the literature on the ongoing epidemic of prescription drugs—and particularly of opioid

analgesics—in this country. This analysis brings a much-needed lifecourse perspective to the investigation of risk factors for NMUPP above and beyond those at the individual level. Its longitudinal, multilevel nature offers a powerful lens that has been rare in research relying solely on cross-sectional data.

While we believe that our study provides valuable new insight, it is not without limitations. First, our measures rely heavily on self-report. While Add Health strives to ensure that participants answer truthfully and accurately by providing more confidential means of answering sensitive questions, there is always a risk of inaccuracy with self-reported information. In our case, both outcome and main independent variables of interest rely on participant and parental self-report. However, it is more likely that substance use would be under-reported rather than over-reported due to desirability bias. Such an error would result in underestimates in our associations, rather than overestimates.

Another limitation of the data lies in the question asked about our outcome, lifetime non-medical use of prescription painkillers. Unfortunately, no questions were asked about the frequency or extent of misuse. Nor were participants queried about the reasons for their misuse of prescription drugs. This lack of detail limits the conclusions we might draw from our results. Questions about misuse of prescription drugs were not asked of participants at baseline (Wave 1, 1994/1995), so we are unable to trace any changes in misuse over time. Finally, we have not weighted our analyses to make our sample nationally representative. Our findings, therefore, can not be generalized to those beyond our sample population.

Conclusions

Our study offers early findings suggesting a lasting impact of school racial composition on students well beyond their years spent in school. This preliminary work highlights the need for a more in-depth, longitudinal examination of the possible pathways—psychosocial, material, or otherwise—that influence risk of prescription drug misuse at the individual and school levels that might help to inform future education and policy efforts.

Acknowledgment

This research uses data from Add Health, a program project directed by Kathleen Mullan Harris and designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris at the University of North Carolina at Chapel Hill, and funded by grant P01-HD31921 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development, with cooperative funding from 23 other federal agencies and foundations. Special acknowledgment is due Ronald R. Rindfuss and Barbara Entwisle for assistance in the original design. Information on how to obtain the Add Health data files is available on the Add Health website (http://www.cpc.unc.edu/addhealth). No direct support was received from grant P01-HD31921 for this analysis.

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Table 1. Weighted Crude Prevalence (%) of Add Health Participants Reporting Prescription Painkiller Misuse at Wave 4 (2008), by Racial Composition of School Attended at Wave 1 (1994/5)

		School-Level Composition (Wave 1)		
	Overall (132 schools)	>50% NHW (88 schools)	>50% NHB (14 schools)	Neither (30 schools)
FULL SAMPLE	**15.8 (n=11,176)**	**17.9 (n=7,111)**	**4.8 (n=833)**	**12.4 (n=3,232)**
Non-Hispanic Blacks	**4.2 (n=2,229)**	5.2 (n=708)	2.8 (n=726)	5.2 (n=795)
Non-Hispanic Whites	**19.4 (n=6,562)**	19.3 (n=5,852)	15.7 (n=60)	21.5 (n=650)
Hispanics	**9.5 (n=1,673)**	12.8 (n=377)	10.3 (n=28)	7.9 (n=1,268)
Others	**11.1 (n=712)**	10.7 (n=174)	0 (n=19)	12.9 (n=519)

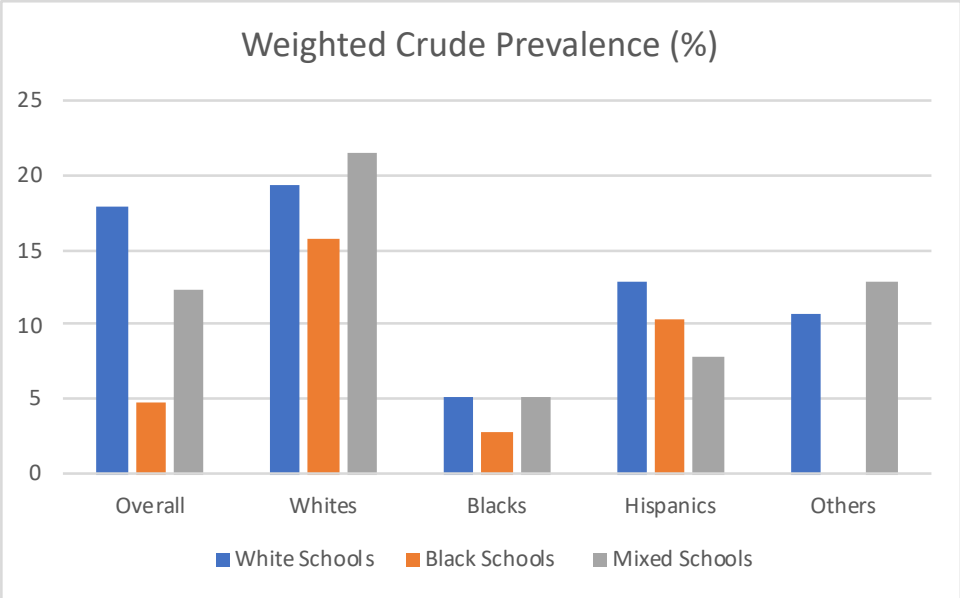
Note: "Majority black" and "majority white" are those with school populations >50% of respective group; "neither" are those remaining schools. Prevalence has been weighted to correct for individuals' probability of selection. 426 observations with non-positive weights were excluded from calculations.

Table 2. Risk Ratios from Two-level Random Intercept Multilevel Models for Self-Reported Rx Painkiller Ever Misuse Among Add Health Participants, Wave 4 (n=11,602)

	Model 3				Model 4					Model 5			
	RR	95% CI		p-val	RR	95% CI		p-val		RR	95% CI		p-val
INDIVIDUAL-LEVEL									**INDIVIDUAL-LEVEL**				
White (ref)	*1.00*				*1.00*				*Black (ref)*	*1.00*			
Black	0.33	0.26	0.41	***	0.39	0.29	0.52	***	White	7.20	3.64	14.25	***
Hispanic	0.59	0.48	0.73	***	0.76	0.58	1.00	0.05	Hispanic	2.04	0.48	8.70	0.34
Other	0.59	0.46	0.77	***	0.69	0.46	1.03	0.07	Other	-	-	-	-
SCHOOL-LEVEL									**SCHOOL-LEVEL**				
Majority White School (ref)	*1.00*				*1.00*				*Maj Black School (ref)*	*1.00*			
Majority Black School	0.66	0.45	0.97	*	1.30	0.74	2.31	0.37	Maj White School	2.14	1.28	3.58	**
Neither Majority School	0.90	0.74	1.10	0.30	1.04	0.83	1.30	0.72	Neither Maj School	1.56	0.90	2.70	0.11
CROSS-LEVEL INTERACTIONS									**CROSS-LEVEL INTERACTIONS**				
White in White Majority School (ref)					*1.00*				*Black in Black Majority School (ref)*	1.00			
Black in Black Majority School					0.36	0.17	0.75	*	White in White Majority School	0.36	0.17	0.75	*
Black in Neither Majority School					0.70	0.44	1.11	0.13	White in Neither Majority School	0.51	0.24	1.11	0.09
Hispanic in Black Majority School					0.37	0.08	1.69	0.20	Hispanic in White Majority School	0.96	0.22	4.33	0.96
Hispanic in Neither Majority School					0.59	0.40	0.88	*	Hispanic in Neither Majority School	0.82	0.18	3.68	0.80
"Other" in Black Majority School					-	-	-	-	"Other" in White Majority School	-	-	-	-
"Other" in Neither Majority School					0.73	0.43	1.24	0.25	"Other" in Neither Majority School	-	-	-	-

Notes: Model 1 includes only individual race. Model 2 adjusts for individual-level covariates: sex, age, household income at Wave I, and parental education. Models 3, 4, and 5 additionally adjust for school-level variables: region of country, school size, and school sector (private vs. public). Model 4's reference group is whites in white schools, while Model 5's reference group is blacks in black schools, to allow for interpretation of relative risk for each classification of students. School-level variables reflect schools attended by participants at Wave 1 (1994/5). Non-medical use of prescription painkillers was reported at Wave 4 (2008). P-values: * <0.05; ** <0.01; *** <0.001.

Figure 1. Weighted Crude Prevalence (%) of Add Health Participants Reporting Ever Prescription Painkiller Misuse in Young Adulthood (Wave 4), by Individual Race and Racial Composition of School Attended (Wave 1)



Notes: For the three mutually exclusive school-level variables: "majority black" and "majority white" are those schools with populations >50% of either respective group; "neither" are those remaining schools. Percentages for "others" from majority non-Hispanic black schools are omitted due to small sample size (n=10; none reported misuse). Prevalence has been weighted to correct for individuals' probability of selection. 426 observations with non-positive weights were excluded from calculations.

Supplemental Table 1. Unweighted Crude Prevalence (%) of Add Health Participants Reporting Prescription Painkiller Misuse at Wave 4 (2008), by Racial Composition of School Attended at Wave 1 (1994/5)

		School-Level Composition (Wave 1)		
	Overall (132 schools)	>50% NHW (88 schools)	>50% NHB (14 schools)	Neither (30 schools)
FULL SAMPLE	**14.1 (n=11,602)**	**17.2 (n=7,377)**	**4.5 (n=888)**	**9.7 (n=3337)**
Non-Hispanic Blacks	**4.9 (n=2,347)**	7.0 (n=748)	3.1 (n=775)	4.9 (n=824)
Non-Hispanic Whites	**19.0 (n=6798)**	18.7 (n=6056)	22.2 (n=63)	20.8 (n=679)
Hispanics	**8.7 (n=1722)**	14.6 (n=391)	6.7 (n=30)	7.0 (n=1301)
Others	**10.5 (n=735)**	13.7 (n=182)	0 (n=20)	9.8 (n=533)

Note: "Majority black" and "majority white" are those with school populations >50% of respective group; "neither" are those remaining schools.

Supplemental Table 2. Breakdown of 132 Schools by Racial Composition and School-Wide Income (Wave 1, 1994/5)

	High-Income (66)	Low-Income (66)
Majority Black (14)	1	13
Majority White (88)	57	31
Neither (30)	8	22

Note: For the cut-off for high- vs low-income schools, the median across schools of median per-person household income is used. "Majority black" and "majority white" are those with school populations >50% of respective group; "neither" are those remaining schools.

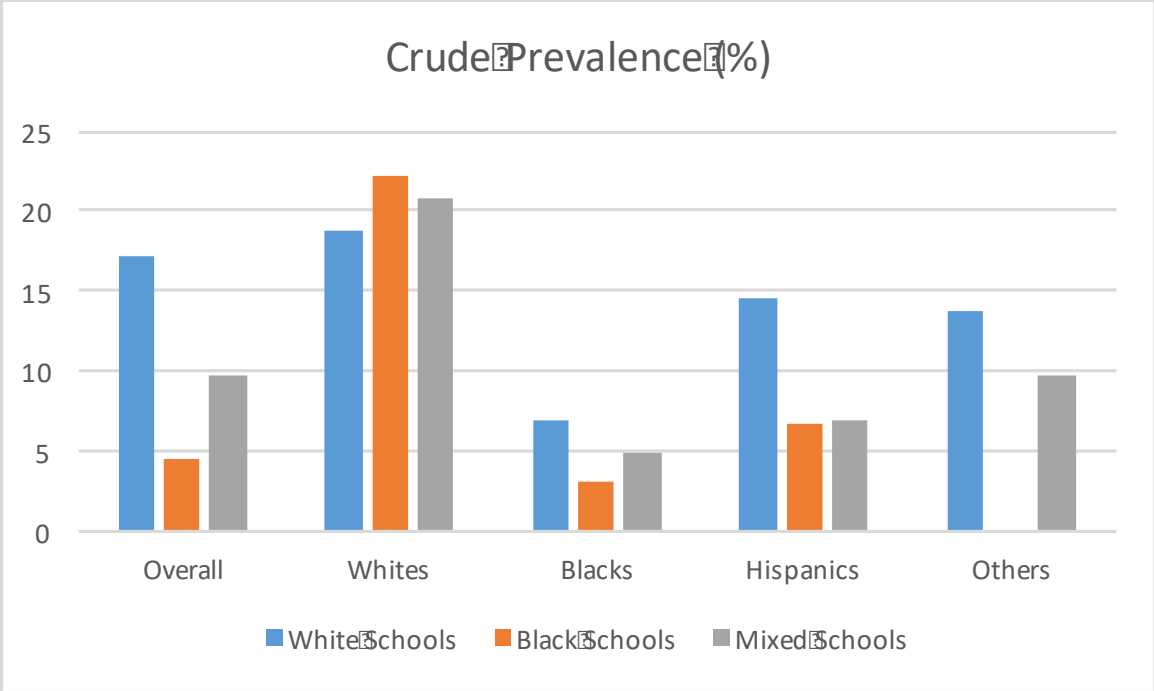
Supplemental Table 3. Crude Prevalence (%) Students Reporting Prescription Painkiller Misuse at Wave 4, By Wave 1 School Racial Composition and High- vs Low-Income School

	>50% Non-Hispanic Black		>50% Non-Hispanic White		Neither	
	4.5%	**N=888**	**17.2%**	**N=7377**	**9.7%**	**N=3337**
	High-Income (n=66)	Low-Income (n=822)	High-Income (n=5068)	Low-Income (n=2309)	High-Income (n=980)	Low-Income (n=2357)
Overall	**4.6**	**4.5**	**18.4**	**14.6**	**12.1**	**8.7**
Non-Hispanic Black	5.8	2.9	8.7	5.4	5.4	4.5
Non-Hispanic White	-	22.2	19.6	16.7	19.1	21.9
Hispanics	-	8.3	14.7	14.3	10.5	6.7
Others	-	-	13.9	13.3	14.7	6.0

Overall high-income=17.2; overall low-income=10.6.

Note: For the cut-off for high- vs low-income schools, the median across schools of median per-person household income was used. "Majority black" and "majority white" are those with school populations >50% of respective group; "neither" are those remaining schools. Percentages for "others" from majority non-Hispanic black schools are omitted due to very small sample sizes (from high-income schools: n=8; low-income schools: 12; all reported no misuse), as is the prevalence for Hispanics from high-income majority black schools (n=6; none reported misuse).

Supplemental Figure 1. Unweighted Crude Prevalence (%) of Add Health Participants Reporting Ever Prescription Painkiller Misuse in Young Adulthood (Wave 4), by Individual Race and Racial Composition of School Attended (Wave 1)



Notes: For the three mutually exclusive school-level variables: "majority black" and "majority white" are those schools with populations >50% of either respective group; "neither" are those remaining schools. Percentages for "others" from majority non-Hispanic black schools are omitted due to small sample size (n=10; none reported misuse).